No.

Carnegie Institute of Technology

Department of Physics

CARNEGIE INSTITUTE OF TECHNOLOGY

Project NR 010-202

Contract N9onr- 88200

Final Report

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Chief Investigators: Professor H. C. Corben, July 1, 1949 - September 30, 1951
Professor L. Wolfenstein, October 1, 1951 - June 30, 1953

Work performed under this contract has been reported in Technical Reports Nos. 1, 2, 3, 4 as under.

Technical Report No. 1

R. A. Charpie, "The motion of a Dirac electron in a uniform electrostatic field."

The method of Johnson and Lippman (Phys. Rev. 76, 828 (1949), 77, 702 (1950)) for motion in a magnetic field was extended to the case of an electric field. The results were compared with those for the magnetic field by means of transformation theory. The relation between the two cases corresponds to that between uniformly accelerated and rotating coordinate systems discussed in Report No. 3.

Technical Report No. 3

H. C. Volkin "Rotating and accelerated reference systems in relativity theory."

Rotation and acceleration may be described simultaneously by a generalization of the Lorentz transformation, the elements of the transformation matrix varying with a parameter which depends on the event. The space rotations and simple Lorentz transformations into which the transformation may be resolved at any value of the parameter change continuously as the parameter varies, giving rotating and accelerated coordinate systems. The angular velocity and acceleration are readily evaluated from the transformation matrix.

For the particular case of pure rotation, classical rigid body motion or a velocity distribution previously obtained by Rosen can be derived depending on the particular formulation of the complete transformation. In the case of pure linear acceleration, a system whose origin moves with constant relativity acceleration is obtained.

Part of the above work was carried out by the chief investigator and communicated to the American Physical Society.

H. C. Corben, Phys. Rev. 78, 329 (1950)

Technical Report No. 2

H. C. Corben "A unified field theory with varying charge and mass."

Kaluza's theory is modified, partly by treating Kaluza's constant a as a general constant and introducing the charge and mass of a particle in a more reasonable manner. The charge and mass are then no longer constants of the motion, the more charge a particle acquires the less its mass becomes when it is free. The constant a is chosen so that the neutron and proton may be regarded as different states of the one particle in this way, thereby making the theory unique.

Without the explicit introduction of meson potentials, it then follows that there exists a short range ($\sim 10^{-13}$cm) attraction between neutron and proton, and a modified and finite Coulomb interaction between two protons. The possibility of charge exchange between colliding neutrons and protons is a consequence of the field equations and the geodesic equations of motions. A photon may acquire a charge and rest mass when extremely close to a charged particle, and the possibility arises for the formation of systems of such charged photons with rest energies of order 100 Mev. Without any special assumptions about the fifth coordinate x^5 it follows that in the linear approximation the electromagnetic potentials are independent of x^5 when the gravitational potentials may

be neglected. Correspondence with classical electrodynamics is established in the limit $a \sim 0$.

This work was continued, without pay, while Professor H. C. Corben was on leave of absence from Carnegie Institute of Technology as a Fulbright Professor to Northern Italy from September 1951 to July 1953. Some of the work has been published in a series of papers as under.

Phys. Rev. 83, 224 (1951) (Abstract)

H. C. Corben, Il Nuovo Cimento 9, 235 (1952)

H. C. Corben, Il Nuovo Cimento 9, 580 (1952)

H. C. Corben, Il Nuovo Cimento 9, 1071 (1952)

H. C. Corben, Phys. Rev. 88, 677 (1952)

and developed by others

P. Caldirola and P. Gulmanelli, Il Nuovo Cimento 9, 834 (1952)

A. Loinger, Il Nuovo Cimento 9, 855 (1952)

B. Bellomo and A.Loinger, Il Nuovo Cimento 9, 1240 (1952)

O. Bergmann and N. Baker, Il Nuovo Cimento 11, (Feb. 1954)

During the absence of Professor H. C. Corben, Professor L. Wolfenstein took over as chief investigator of the contract.

Technical Report No. 4

W. Lakin and L. Wolfenstein, "Theory of nuclear reactions involving polarized deuterons."

Observations on the polarization of nuclear particles are a recently-developed tool for studying nuclear interactions. In this paper, possibilities of producing and detecting the polarization of deuterons are discussed.

The polarization state of a deuteron may be specified by giving the

statistical expectation values of a "complete set" of spin operators. This complete set consists of one scalar (unity), the three components of a pseudo-vector (the total spin), and the five components of an irreducible second-rank tensor. If the polarized deuteron is produced in a simple reaction such that the initial and final states define one momentum each, invariance conditions require the normal to the reaction plane to be the spin direction and also a principal axis of the second-rank tensor. The possible states of polarization of the deuterons produced in the reaction $p + p \rightarrow \pi^{+} + d$ are calculated in this paper. Previous considerations had been limited to the spin, but actually polarization effects associated with the second rank tensor appear to be more prominent. Detection by scattering from unpolarized protons is also considered; one finds that the tensor-type polarization has a considerable effect even in the Born approximation.

Submitted by

H. C. Corben

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Chief Investigator

HCC:mdm